SCIENCES SORBONNE UNIVERSITÉ

2020-2021

Master thesis proposal

Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie

Campus Pierre et Marie Curie
Tower 23 - 4th floor -23-22
Director: Guillaume Fiquet

Title: Characterization of New Phases at Extreme Conditions

Keywords: Extreme Conditions Experiments, planetary interiors

Scientific description:

Oxygen and iron are the Earth's most abundant elements by number of atoms and by mass, respectively. They form compounds dictating major chemical processes of our planet. It is conventionally accepted that the O anion has an unvarying −2 valence state in rock-forming minerals. The redox states are believed to be mostly controlled by the 3d transition element Fe which could vary among three valence states, metallic Fe^{0}, ferrous Fe^{2+}, and ferric Fe^{3+}, giving rise to the well-known oxides at ambient conditions: FeO, Fe_3O_4, and Fe_2O_3. However our recent findings on new phases with unusual oxygen valence state (O^{-1}) are challenging this general conception. These new phases are stable at the extreme pressure and temperature conditions making them potential candidates for deep planetary interiors.

The aim of this master thesis internship is to describe these new high pressure phases and determine the spectroscopic signatures of the new oxygen valence (O^{-1}). The phases will be synthesized experimentally at extreme conditions in diamond anvil cells coupled with a laser heating system or in a multi-anvil press at the laboratory IMPMC. Characterization will be conducted by combining multiple probes such as Raman spectroscopy, Transmission Electron Microscopy as well as Synchrotron Radiation-based X-Ray Scattering.
The student will have the opportunity to pursue this project within the frame of a PhD thesis founded by the AnR project "OXYGEN". She or he will be working on the determination of the phase diagram of Fe-O-H system at extreme conditions using both an experimental and a theoretical approach (ab initio calculation on the phase diagram and DFT calculation on the O K-edge of new high-pressure compounds).

Techniques/methods in use: Laser Heated Diamond Anvil Cell and Multi-anvil Press, Synchrotron Radiation-based X-ray Scattering, Transmission Electron Microscopy and Electron Energy Loss Spectroscopy
Applicant skills: crystallography, interest in the high pressure experimental work, interest in planetary interiors will be a plus
Industrial partnership: No
Internship supervisor(s) (name, email, phone, webmail): Eglantine Boulard, 0144274807, eglantine.boulard@upmc.fr
Internship location: Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, Campus Jussieu, Paris
Possibility for a Doctoral thesis: Yes, financed by the ANR OXYGEN